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Saphenous surgery does not correct perforator incompetence in the presence of deep venous reflux

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Purpose: **To determine which patients require subfascial endoscopic perforator surgery (SEPS) in addition to saphenous surgery to correct pathologic outward flow within incompetent medial calf perforating veins (IPVs).**
Methods: **Sixty-two limbs of 47 patients undergoing sapheno-femoral ligation, stripping of the long saphenous vein in the thigh, and multiple phlebectomies (n = 51), sapheno-popliteal ligation and multiple phlebectomies (n = 10), or both (n = 1) were examined with color flow duplex ultrasound scan immediately before and a median of 14 weeks (range, 6 to 26 weeks) after the operations. Indications for surgery were varicose veins (n = 47, Clinical, Etiologic, Anatomic, Pathophysiologic grades $C_{2\&3}$), skin changes (n = 5, C_4), and ulceration (n = 10, C_5).**
Results: **Surgery resulted in a significant reduction in the total number of limbs in which IPVs were imaged (40/62 or 65% preoperatively vs 23/62 or 37% postoperatively, $P < .01$, χ^2 test), a significant reduction in the proportion of perforators imaged that were incompetent (68/130 or 52% preoperatively vs 34/120 or 28% postoperatively, $P < .01$, χ^2 test), and a reduction in median IPV diameter (4 mm, with a range of 1 to 11 mm preoperatively, vs 3, with a range of 1 to 8 mm postoperatively, $P < .01$, Mann-Whitney U test). IPVs remained in 8 of 41 (20%) limbs in which main stem reflux was abolished, compared with 15 of 21 (72%) limbs in which superficial or deep reflux remained ($P < .01$, χ^2 test).**
Conclusion: **Eradication of main stem saphenous reflux corrects IPV reflux in most cases in which reflux is confined to the superficial system. However, in patients with superficial reflux that persists postoperatively, or when there is coexistent deep venous reflux, saphenous surgery alone fails to correct IPVs reflux. In these circumstances, the only way of reliably correcting pathologic outward flow in medial calf perforating veins is to perform SEPS. (J Vasc Surg 1998;28:834-8.)**

A variety of surgical procedures designed to interrupt incompetent medial calf perforating veins (IPVs) have been described and advocated for the management of chronic venous insufficiency (CVI).[1-4] However, it is now widely agreed that open perforator ligation (Linton's procedure) is associated with an unacceptable level of morbidity, and, therefore, the procedure has largely been abandoned. The advent of subfascial endoscopic perforator surgery (SEPS)[5,6] has rekindled the debate about the role of perforators in the pathogenesis of CVI and reawakened interest in their surgical interruption.[7] Although the feasibility, safety, and early efficacy of SEPS has been confirmed by reports from both Europe[8] and North America,[9] and the significant advantages SEPS has over Linton's procedure have been clearly demonstrated,[10] the indications for this operation remain controversial.[11,12] Uncontrolled data support the contention that, in the presence of isolated superficial venous reflux, saphenous surgery comprising sapheno-femoral ligation, stripping of the long saphenous vein in the thigh, and multiple phlebectomies or sapheno-popliteal ligation and multiple phlebectomies, as indicated, promotes healing and

From the University Department of Surgery, Royal Infirmary.
Presented at the Tenth Annual Meeting of the American Venous Forum, Lake Buena Vista, Fla, Feb 18–21, 1998.
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0741-5214/98/$5.00 + 0 **24/6/92674**

reduces recurrence of chronic venous ulceration.[13,14] However, most patients with venous ulceration have deep venous reflux, either in isolation or in combination with superficial reflux, together with more dilated medial calf perforating veins permitting outward pathological flow.[15] In these circumstances, the beneficial effects of saphenous surgery alone are less certain. Although several authors have advocated and reported low recurrence rates after perforator ligation and saphenous surgery,[16,17] others have suggested that saphenous surgery alone will correct IPV reflux, rendering direct perforator interruption unnecessary.[18] Our aim, therefore, was to determine which patients, if any, require SEPS in addition to standard saphenous surgery to correct pathologic flow within medial calf perforating veins.

PATIENTS AND METHODS

The series comprised 47 patients (18 male, 29 female; median age, 58 years; range, 35 to 77 years; 62 limbs) who underwent sapheno-femoral ligation, stripping of the long saphenous vein in the thigh, and multiple phlebectomies (n = 51), sapheno-popliteal ligation and multiple phlebectomies (n = 10), or both (n = 1). The indications for surgery were varicose veins (n = 47, Clinical, Etiologic, Anatomic, Pathophysiologic [CEAP] clinical classes 2 and 3), skin changes (n = 5, CEAP clinical class 4), and ulceration (n = 10, CEAP clinical class 5). Three patients had clearly documented histories of deep venous thrombosis (DVT; CEAP etiologic class E_S). The remaining 10 patients with deep venous reflux may have suffered either a subclinical or unrecognized episode of DVT, or alternatively represent cases of primary deep venous valvular insufficiency (CEAP etiologic class E_P). The presence of venous reflux in the deep and superficial systems and in medial calf perforating veins was determined by means of color flow duplex ultrasonography using a 4 MHz linear array transducer (Ultramark 9, Advanced Technology Laboratories, Bothell, Wash). Examinations were performed immediately before surgery and a median of 14 weeks (range, 6 to 26 weeks) postoperatively. Reflux was considered to be pathologic if it exceeded 0.5 seconds. Main stem deep reflux, superficial reflux, or both was elicited with the patient in the erect position after induction of cephalad venous flow by means of a calf squeeze. Medial calf perforating veins were examined with the patient seated and with the legs dependent, hanging freely. A medial calf perforating vein was defined as a vessel lying between the medial subcutaneous border of the tibia and the posterior midline of the calf that was clearly seen to be crossing the deep fascia.[8] The maximum diameter of each perforator was measured. Flow through the perforator was induced by squeezing and then releasing the foot, and flow was recorded using the color flow and the spectral Doppler functions. A vessel was determined to be incompetent if any outward flow was observed with either method.

Long saphenous surgery comprised flush ligation of the sapheno-femoral junction, stripping of saphenous vein to immediately below the knee, and multiple phlebectomies. Short saphenous surgery comprised flush sapheno-popliteal ligation and multiple phlebectomies. When performing phlebectomies, the surgeon was instructed to avoid avulsing varices in the immediate vicinity of the medial calf perforating veins, which had been localized and marked preoperatively.

RESULTS

The pattern of preoperative deep and superficial main stem venous reflux is shown in Table I. Medial calf perforating veins, competent or incompetent, were imaged in 60 limbs both preoperatively and postoperatively. In 2 limbs, medial calf perforating veins were not imaged either before of after surgery. Surgery was associated with a small reduction in the total number of perforators, competent or incompetent, imaged (preoperatively, n = 130 vs postoperatively, n = 120); a significant reduction in the total number of limbs in which incompetent perforators were imaged (40/62 or 65% preoperatively vs 23/62 or 37% postoperatively, $P < .01$, χ^2 test); a significant reduction in the proportion of perforators imaged that were incompetent (68/130 or 52% preoperatively vs 34/120 or 28% postoperatively, $P < .01$, χ^2 test); and a reduction in median diameter (4 mm, with a range of 1 to 11 mm preoperatively, vs 3 mm, with a range of 1 to 8 mm postoperatively, $P < .01$, Mann-Whitney U test) of all perforators imaged.

IPVs were detected postoperatively in only 8 of 41 (20%) limbs in which main stem venous reflux was abolished by means of surgery and deep venous reflux was absent. By comparison, IPVs were imaged in 15 of 21 limbs (72%) in which deep venous reflux was present or surgery failed to completely eradicate main stem superficial reflux ($P < .01$, χ^2 test). IPVs were imaged in 14 of 47 limbs (30%) operated on for uncomplicated varicose veins (CEAP clinical class 2 and 3), compared with 9 of 15 limbs (60%) operated on for LDS (CEAP clinical class 4) or healed ulceration (CEAP clinical class 5; $P < .05$, χ^2 test). The relationship between the postoperative distribution of main stem venous reflux and the presence of

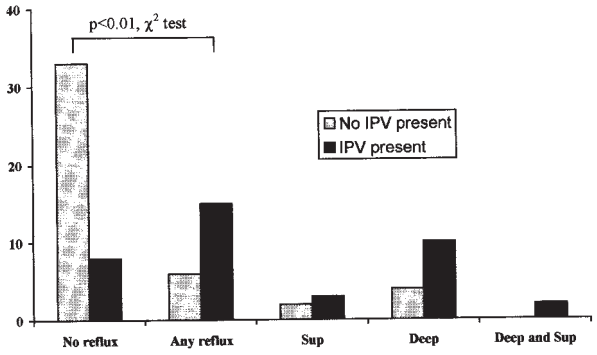

Fig 1. The effect of postoperative reflux on the proportion of limbs demonstrating IPVs. *IPV,* Incompetent perforating vein; *Sup,* superficial system reflux; *Deep,* deep system reflux. Deep reflux numbers exclude common femoral vein reflux.

Table I. Sites of pathologic venous reflux

Site of reflux	*Preoperative n (%)*	*Postoperative n (%)*
Long saphenous vein	55 (89)	4(6)
Short saphenous vein	12 (19)	3 (5)
Common femoral vein	36 (58)	26 (58)
Superficial femoral vein	8 (13)	7 (11)
Popliteal vein	6 (10)	6 (10)
Posterior tibial vein	6 (10)	6 (10)
Superficial reflux only	49 (79)	5 (8)
*Deep reflux only	–	14 (23)
*Deep and superficial reflux	13 (21)	2 (3)

*Excluding common femoral vein reflux.

IPVs is shown in Fig 1. All 6 patients in whom posterior tibial vein reflux was demonstrated also had IPVs postoperatively, as did the 3 patients with clear histories of DVT.

DISCUSSION

In patients undergoing saphenous surgery in the presence of an apparently healthy deep venous system, complete eradication of main stem superficial reflux leads to correction of pathological outward flow in medial calf perforating veins in most (33 of 41), but not all, cases.

In those cases in which outward flow was abolished by means of surgery, one might hypothesize that medial calf perforating veins have been rendered incompetent preoperatively because of (reversible) dilatation caused by excessive filling of the deep venous system from the refluxing saphenous system during calf muscle pump diastole. Eradication of superficial venous reflux allows perforating veins to return to their normal diameter and regain competence. That superficial venous reflux may overload the deep venous system leading to "secondary" deep venous reflux is supported by 2 previous studies showing that surgical eradication of superficial venous reflux can correct reflux in the femoral vein, presumably because of removal of thigh perforators at the time of superficial venous stripping.[19,20] We observed a similar effect of superficial surgery on femoral vein and calf perforating vein incompetence, but not on popliteal or tibial vein incompetence, possibly because in this study calf perforating veins were purposely left undisturbed.

An alternative explanation of the changes in IPV competence is that medial calf perforating veins were simply disrupted during the performance of multiple calf phlebectomies. Although perforators were localized and marked preoperatively and the surgeon was requested to refrain from performing phlebectomies in their immediate vicinity, one cannot exclude the possibility that perforating veins were interrupted. Thus, the total number of perforators imaged fell from 130 preoperatively to 120 postoperatively. A third possible explanation is that, although the great majority of perforators clearly remained in situ despite calf phlebectomies, the outflow from the perforators was decreased or obstructed.

In 8 patients, surgical eradication of superficial main stem reflux did not abolish outward flow in medial calf perforating veins, despite the presence of apparently healthy deep venous systems. In these cases, one might speculate that, despite saphenofemoral disconnection, stripping of the long saphenous vein in the thigh, and multiple phlebectomies, a sufficient degree of reflux remains in one or more tributaries to maintain perforator incompetence. Alternatively, these patients may have had a degree of posterior tibial vein reflux that was not apparent on duplex scanning, or the dilatation of the perforators had been so long-standing that, despite removal of saphenous reflux, they could not regain competence.

Therefore, in the absence of deep venous reflux, eradication of main stem superficial reflux by means of standard saphenous surgery will normalize 80% of medial calf IPVs. These data may explain why previous authors have reported excellent long-term ulcer healing after saphenous surgery alone in patients with ulceration and isolated superficial venous reflux.[13,14] At the present time, it is not possible to identify preoperatively the 20% of patients who may benefit from SEPS because their IPVs will not be corrected by saphenous surgery.

Previous work from our unit and other units has demonstrated that most patients with venous ulceration have deep reflux, with or without superficial reflux, and more incompetent medial calf perforators when compared with patients with uncomplicated varicose veins.[15,21,22] The present study clearly indicates that, in such patients, saphenous surgery alone fails to correct outward perforator flow in the great majority of cases. This is perhaps to be expected, because removal of superficial varices will not affect the transmission of high pressure venous blood from the calf muscle pump to the microcirculation of the skin of the gaiter area (the so-called "blow-out" syndrome).[23] The only means of interrupting this pathway is by performing direct perforator interruption, preferably by means of SEPS.

These and previous data have lead the Edinburgh group to develop a perforator classification based on the distribution of venous reflux associated with the IPVs and the type of venous surgery required to correct pathological outward perforator flow:

Type I IPVs: fed by a refluxing saphenous vein (long and/or short) in the presence of a normal deep system. In most (80%) of these cases, saphenous surgery alone will correct outward perforator flow.

Type II IPVs: found in association with isolated deep venous reflux. That is, there is no significant saphenous reflux. In these circumstances, IPVs may require direct surgical interruption.

Type III IPVs: found in association with mixed superficial and deep venous reflux. In these circumstances, saphenous surgery alone is inadequate, and on the basis of present data, SEPS appears to be required to correct outward flow.

Type IV IPVs: act as part of a collateral circulation bypassing an occluded deep venous system. Such IPVs must be clearly identified, because perforator interruption, with or without saphenous extirpation, could be detrimental to the patient.

Type V IPVs: occur in the apparent absence of other venous reflux or obstruction. In our experience, these constitute a small group.

Based on the Edinburgh classification, the incidence of the 5 types of IPV in this population were: type I IPV, 47 limbs (76%); type II IPV, 0 limbs; type III IPV, 13 limbs (21%). Type IV IPV were not encountered in this study. However, most patients in the present series were operated on for uncomplicated varicose veins, and among a population of ulcer patients, one might expect types II and III to predominate, thus making the numbers of patients who might benefit from SEPS considerably higher.

Widely disparate results have been reported after perforator surgery, leading to continued controversy about the appropriateness of perforator ligation in the management of different grades of venous disease. This may, in large part, be caused by differences in case mix and selection between series. For example, we would not expect patients with type I IPVs to gain any additional hemodynamic or clinical benefit from perforator ligation performed in addition to standard saphenous surgery in most cases. Furthermore, perforator ligation in patients with type IV IPVs may be detrimental. In contrast, saphenous surgery alone may not lead to ulcer healing in the presence of type III IPVs. These factors should be taken into account when selecting patients for SEPS and when designing trials to demonstrate the efficacy of SEPS in the management of CVI.

However, these patients represent a different population from those in whom SEPS is performed. We reserve SEPS for those patients with signs of lipodermatosclerosis and ulceration. Type IV and type V IPV are not represented in this population. Isolated (type V) IPVs are rare, and we feel that SEPS is not indicated in patients with significant deep vessel obstruction or stenosis. Superficial venous surgery may also be detrimental to limb hemodynamics, as indicated by tourniquet testing. We now routinely perform SEPS and superficial vein surgery during the same operation.

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Submitted Feb 25, 1998; accepted May 19, 1998.

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